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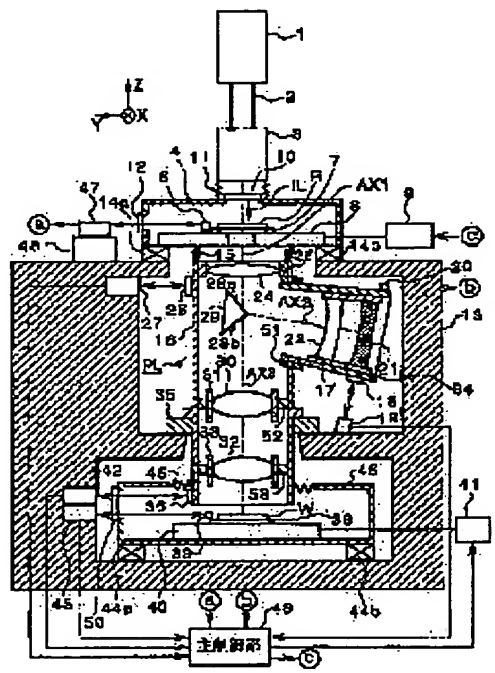
(54) METHOD AND EQUIPMENT FOR PROJECTION EXPOSURE AND METHOD FOR MANUFACTURING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain excellent exposure precision in the case that a catadioptric projection optical system having a plurality of partial lens-barrels having mutually intersecting optical axes is used.



SOLUTION: A reticle R is illuminated with an exposure light IL in a vacuum ultraviolet region, and an image of a pattern of the reticle R which is obtained by using an projection optical system PL is projected on a wafer W. The projection optical system PL is provided with lens groups 24, 30, 32 and a reflection mirror block 29 which are held in the partial lens-barrel 16, and a lens group 22 and a concave mirror 21 which are held in the partial lens-barrel 17. The partial lens-barrel 16 is retained with a main body frame 13, and the partial lens-barrel 17 is retained with the partial lens-barrel 16. Position fluctuation amount of the partial lens-barrel 17 to the main body frame 13 is measured by using a laser interferometer 19. Position deviation amount of a projected image of the reticle pattern is predicted on the basis of the measured value, and a position of the reticle R or the wafer W is adjusted so as to cancel the position deviation amount.

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CLAIMS

[Claim(s)]
[Claim 1] The reflective refraction projection optics which has two or more partial lens-barrels with the optical axis extended in the mutually different direction is used. Are the projection exposure approach which imprints the pattern on a mask on a substrate, and the amount of displacement of at least one partial lens-barrel in said two or more partial lens-barrels is measured. The projection exposure approach characterized by adjusting one [at least] location of said mask and said substrate in order to maintain the physical relationship of the image by said reflective refraction projection optics of the pattern of said mask, and said substrate in the predetermined condition based on the displacement information acquired by this measurement.
[Claim 2] The part I part lens-barrel in which said two or more partial lens-barrels have the 1st optical axis extended from said mask side to said substrate side, The partial lens-barrel for [said] measurement is the projection exposure approach according to claim 1 which is said part II part lens-barrel, and is characterized by measuring the amount of displacement of said part II part lens-barrel to said part I part lens-barrel including the part II part lens-barrel with the 2nd optical axis which intersects said 1st optical axis.
[Claim 3] It is the projection exposure approach according to claim 1 characterized by the partial lens-barrel for [said] measurement containing a reflecting mirror and a lens while the partial lens-barrel for [said] measurement is a partial lens-barrel in the location distant from said mask and said substrate of said two or more partial lens-barrels.
[Claim 4] The reflective refraction projection optics which has two or more partial lens-barrels with the optical axis extended in the mutually different direction is used. The metering device which is a projection aligner which imprints the pattern on a mask on a substrate, and measures the amount of displacement of at least one partial lens-barrel in said two or more partial lens-barrel groups, The projection aligner characterized by having stage equipment which adjusts one [at least] location of said mask and said substrate based on the displacement information measured by said metering device.
[Claim 5] Said metering device is a projection aligner according to claim 4 characterized by having a laser interferometer.
[Claim 6] Said metering device is a projection aligner according to claim 4 characterized by having an acceleration sensor and the arithmetic unit which computes the amount of displacement of the partial lens-barrel for measurement from the acceleration information which this acceleration sensor measured.
[Claim 7] They are claims 4 and 5 characterized by the partial lens-barrel for [said] measurement containing a reflecting mirror and a lens while the partial lens-barrel for [said] measurement is a partial lens-barrel in the location distant from said mask and said substrate of said two or more partial lens-barrel groups, or a projection aligner given in 6.
[Claim 8] Said projection optics is a projection aligner given in any 1 term of claims 4-7 characterized by having the reflecting mirror of the 2nd page which reflects an exposure beam, and holding the reflecting mirror of these two fields in one at one maintenance block.
[Claim 9] Claims 1 and 2 or the device manufacture approach including the process which imprints a device pattern on a work piece using the projection exposure approach of a publication to 3.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] a photolithography for this invention to manufacture various devices, such as a semiconductor device, image sensors (CCD etc.), a liquid crystal display component, or the thin film magnetic head, -- it is in process, and it is used when using the projection optics which consists especially of reflective refractive media about the projection exposure approach and equipment which are used in order to imprint a mask pattern on a sensitization substrate, and it is suitable.
[0002]
[Description of the Prior Art] At the photolithography process for forming the detailed pattern of electron devices, such as a semiconductor integrated circuit and a liquid crystal display, the approach of carrying out the contraction imprint of the patterns (or photo mask etc.) of the reticle as a mask which carried out proportionality expansion of the pattern which should be formed at about 4 to 5 times, and drew on the wafers (or glass plate etc.) as an exposed substrate using the projection aligner of an one-shot exposure method or a scan exposure method is used.
[0003] In the projection aligner used for the imprint of the detailed pattern, since it corresponds to detailed-ization of a semiconductor integrated circuit, the exposure wavelength is shifting to a short wavelength side more. Although the KrF excimer laser of the exposure wavelength is in use 248nm now, no less than 193nm of the ArF excimer laser it can be considered that is a vacuum ultraviolet area (VUV:Vacuum Ultraviolet) more substantially [short wavelength] is going into a utilization phase. And F2 [with a still shorter wavelength of 157nm] Laser and Ar2 with a wavelength of 126nm The proposal of the projection aligner which uses the exposure light source of vacuum ultraviolet areas, such as laser, is also performed.
[0004]
[Problem(s) to be Solved by the Invention] The flux of light of the wavelength of these vacuum ultraviolet areas has low transmission in usual optical glass, and refraction members (lens etc.) and an optical material usable as a reticle are limited to the quartz glass with which fluoride crystals and predetermined impurities, such as fluorite, magnesium fluoride, and lithium fluoride, were doped. However, the optical material which has advanced homogeneity which is required of the projection optics with which the projection aligner is equipped, and high permeability is substantially limited only to fluorite in the present condition. When it constitutes projection optics from refractive media, in order to use only one kind of optical material such and to amend the chromatic aberration of projection optics good, it is necessary to narrow-band-ize extremely wavelength width of face of the laser beam as an exposure light.
[0005] However, like a vacuum ultraviolet area, the laser light source of short wavelength will have low oscillation effectiveness, extreme narrow band-ization which lowers the oscillation effectiveness further will cause the fall of a laser output, the exposure illuminance on a wafer will be reduced sharply, and the throughput (throughput) of an aligner will be reduced sharply. Then, in order to maintain a laser output on the level from which a practical throughput is obtained and to amend chromatic aberration good, it is possible to constitute projection optics from reflective refractive media.
[0006] However, when adopting cata-dioptric system, it is essentially difficult to perform separation with the incident light to a reflecting mirror, and the reflected light with simple structure, and lens-

barrel structure will be complicated for the separation. Therefore, it becomes difficult to adopt the configuration of the straight cylinder mold which arranges a lens in accordance with one optical axis adopted by the projection optics which consists of the conventional dioptric system by the projection optics which consists of reflective refractive media. That is, the lens-barrel structure of reflective refractive media turns into the complicated structure where two or more partial lens-barrels are arranged with a respectively original optical axis. With such complicated lens-barrel structure, many normal modes of vibration cannot but arise compared with the lens-barrel structure of the conventional straight cylinder mold, and it cannot but become unstable structure mechanically.

[0007] Moreover, when it originates, for example in the vibration accompanying migration of a reticle stage and a wafer stage and vibration or the variation rate of such a lens-barrel occurs, the location of the projection image of the reticle pattern on a wafer shifts according to the above-mentioned vibration or a variation rate, and there is a possibility that the imprint precision of an image may deteriorate. Since the pattern which the projection aligner which makes light of such a vacuum ultraviolet area exposure light exposes is a detailed pattern with a line breadth of dozens of nm, the shift amount of the pattern imprint image resulting from vibration of such a lens-barrel turns into an amount of about several nm, but even if it is a shift amount of this amount, the effect which it has on exposure precision, such as resolution, imprint fidelity, and superposition precision, is quite large, and a certain cure is needed.

[0008] This invention aims at offering the exposure technique in which a good exposure precision is acquired, when using the projection optics (reflective refraction projection optics) which consists of cata-dioptric system which has two or more partial lens-barrels in view of this point.

[0009]

[Means for Solving the Problem] The reflective refraction projection optics (PL) which has two or more partial lens-barrels (16 17) with the optical axis extended in the mutually different direction is used for the projection exposure approach by this invention. It is the projection exposure approach which imprints the pattern on a mask (R) on a substrate (W). The amount of displacement of at least one partial lens-barrel in two or more of the partial lens-barrels (17) is measured. In order to maintain the physical relationship of the image by that reflective refraction projection optics of the pattern of that mask, and its substrate in the predetermined condition based on the displacement information acquired by this measurement, one [at least] location of that mask and its substrate is adjusted.

[0010] according to this this invention -- the inside of two or more of those partial lens-barrels -- for example, the variation rate of the partial lens-barrel which is easy to vibrate -- an amount measures -- having -- this variation rate -- an amount -- being based -- count -- or the amount of location gaps of the projection image of a mask pattern is predicted by the relation for which it has asked beforehand experimentally. And good exposure precision (resolution, imprint fidelity, superposition precision, etc.) is acquired by adjusting the location of a mask or a substrate (or both) so that the amount of location gaps predicted may be offset.

[0011] In this case, the part I part lens-barrel in which two or more of those partial lens-barrels have the 1st optical axis (AX1, AX3) extended from that mask side to that substrate side (16), When the part II part lens-barrel (17) with the 2nd optical axis (AX2) which intersects the 1st optical axis shall be included, it is desirable to measure the amount of displacement of the part II part lens-barrel to the part I part lens-barrel by using the partial lens-barrel for [the] measurement as the part II part lens-barrel (17). With such a configuration, since the part II part lens-barrel is aslant arranged for example, to the direction of a vertical and becomes easy to vibrate, the amount of relative displacements to the part I part lens-barrel of the part II part lens-barrel is measured, it is adjusting the location of a mask or a substrate according to the result, and a good exposure precision is acquired in few measure points.

[0012] However, it is also possible to measure namely, measure the amount of displacement of the partial lens-barrel for measurement using an acceleration sensor etc. on the basis of the location of the partial lens-barrel for measurement itself till then. Moreover, it is desirable for the partial lens-barrel for [the] measurement to contain the reflecting mirror and the lens as a partial lens-barrel which is in the location distant from the mask and its substrate of two or more of the partial lens-barrels about the partial lens-barrel for [the] measurement. While the effect of the variation rate of

the partial lens-barrel in the location distant from the mask and substrate is large, since the effect of the variation rate becomes still larger by including a reflecting mirror, it is measuring the amount of displacement of the partial lens-barrel, and a high exposure precision is acquired.
[0013] Next, the reflective refraction projection optics (PL) which has two or more partial lens-barrels (16 17) with the optical axis extended in the mutually different direction is used for the projection aligner of this invention. The metering device which is a projection aligner which imprints the pattern on a mask (R) on a substrate (W), and measures the amount of displacement of at least one partial lens-barrel in two or more of the partial lens-barrel groups (17), Based on the displacement information measured by the metering device, it has stage equipment (7 38) which adjusts one [at least] location of the mask and its substrate.
[0014] The exposure approach of this invention can be enforced by this invention. In this case, that metering device has a laser interferometer (18 19) as an example. Moreover, that metering device has the arithmetic unit (49) which computes the amount of displacement of the partial lens-barrel for measurement as another example from the acceleration information which an acceleration sensor (20) and this acceleration sensor measured.
[0015] Moreover, that projection optics has the reflecting mirror (28a, 28b) of the 2nd page which reflects an exposure beam as an example, and this reflecting mirror of the 2nd page is held in one at one maintenance block (29). Thus, the effect of vibration decreases by holding the reflecting mirror of the 2nd page in one. Moreover, the device manufacture approach of this invention includes the process which imprints a device pattern on a work piece (W) using the projection exposure approach of this invention. By this invention, since a high exposure precision is acquired without performing narrow band-ization of extreme wavelength width of face even when for example, vacuum-ultraviolet light is used as an exposure beam, an exposure illuminance can be maintained highly and the device of a detailed pattern can be mass-produced by the high throughput.
[0016]
[Embodiment of the Invention] Hereafter, with reference to a drawing, it explains per example of the gestalt of operation of this invention. When exposing with the projection aligner equipped with the projection optics which consists of reflective refractive media, it applies this invention, while vacuum-ultraviolet light (VUV light) is used for this example as an exposure beam.
[0017] It is the outline block diagram showing the projection aligner of this example, it sets to this drawing 1 , and drawing 1 is F2 [with an oscillation wavelength / of a vacuum ultraviolet area / of 157nm] as the exposure light source 1. Laser (fluorine laser) is used. It is Kr2 with an oscillation wavelength of 146nm as the exposure light source in addition to it. Ar2 with a laser (krypton dimer laser) and an oscillation wavelength of 126nm This invention is effective also when using the light source of a vacuum ultraviolet area substantially [laser (argon dimer laser), ArF excimer laser with an oscillation wavelength of 193nm, the higher-harmonic generator of an YAG laser, or the higher-harmonic generator of semiconductor laser]. Moreover, even if this invention is the case where wavelength uses exposure light 200nm or more like KrF excimer laser (wavelength of 248nm), the structure of projection optics can apply it like reflective refractive media, when complicated.
[0018] The exposure light IL as an exposure beam injected from the exposure light source 1 illuminates the pattern side (inferior surface of tongue) of the reticle R as a mask through the beam matching unit (BMU) 2, the illumination-light study system 3, and the window part material 10. The illumination-light study system 3 is equipped with an optical integrator, the aperture diaphragm (sigma diaphragm) of an illumination system, the relay lens system, the field diaphragm, the condensing lens system, etc. The beam matching unit 2 and the illumination-light study system 3 are contained in the airtight high subchamber (un-illustrating), respectively.
[0019] The exposure light IL which penetrated Reticle R forms the image of the pattern of the reticle R on the wafer (wafer) W as an exposed substrate through the projection optics PL which consists of reflective refractive media of this example. Wafers W are disc-like substrates, such as semi-conductors (silicon etc.) or SOI (siliconon insulator), and the photoresist (sensitive material) is applied on it. The 1st lens group 24 to which the projection optics PL of this example uses the 1st optical axis AX1 as an optical axis, The reflecting mirror block 29 with which the plane mirrors (reflector) 28a and 28b of the 2nd page were formed in the front face, It has the lens group 22 and concave mirror 21 which use as an optical axis the 2nd optical axis AX2 which crosses to the 1st

optical axis AX1, and the 2nd lens group 30 and the 3rd lens group 32 which uses the 3rd optical axis AX3 as an optical axis.
[0020] And after the image formation flux of light from Reticle R penetrates the 1st lens group 24, it reflects by reflecting mirror 28a, and it penetrates the lens group 22, it results in a concave mirror 21, it reflects here, and it penetrates the lens group 22 again, and results in reflecting mirror 28b. The image formation flux of light reflected by reflecting mirror 28b penetrates the 2nd lens group 30 and the 3rd lens group 32 continuously, and forms the projection image of the pattern on Reticle W on Wafer W. The image formation scale factors from the reticle of projection optics PL to a wafer are 1 / about 4 to 1/5-time contraction scale factor, and the interior of projection optics PL is also made airtight.
[0021] In projection optics PL, the 1st lens group 24, the reflecting mirror block 29, the 2nd lens group 30, and the 3rd lens group 32 are held by the 1st partial lens-barrel 16 in common. In this example, the optical axis AX1 of the 1st lens group 24 is perpendicular to the pattern side (reticle side) of Reticle R, the optical axis AX3 of the 2nd lens group 30 and the 3rd lens group 32 is perpendicular to the exposure side (wafer side) of Wafer W, and the optical axis AX1 and the optical axis AX3 are the same shaft. And a wafer side is a horizontal plane mostly and opticals axis AX1 and AX3 are prolonged in the direction of a vertical. However, both opticals axis AX1 and AX3 do not necessarily need to be the same shafts. Moreover, the 1st lens group 24 is held according to the maintenance device 25 at the partial lens-barrel 16, and the 3rd lens group 32 is held for the 2nd lens group 30 through the maintenance device 33 and the justification device 53 through the maintenance device 31 and the justification device 52 at the partial lens-barrel 16, respectively.
[0022] On the other hand, the lens group 22 and concave mirror 21 which use the 2nd optical axis AX2 as an optical axis are held through the maintenance device 34 at the 2nd partial lens-barrel 17, and the 2nd partial lens-barrel 17 is mechanically combined by the connection member 51 to the 1st partial lens-barrel 16. And the flange prepared in the 1st partial lens-barrel 16 is installed through opening prepared in the body frame 13 (after-mentioned) through the mounting section 35. That is, projection optics PL is supported by the body frame 13 as a whole, and the 2nd partial lens-barrel 17 is supported by the 1st partial lens-barrel 16 in projection optics PL. The Z-axis is taken hereafter in parallel with the optical axis AX1 of the 1st lens group 22 in projection optics PL, in a flat surface perpendicular to the Z-axis, at right angles to the space of drawing 1 , in parallel with the space of drawing 1 , a Y-axis is taken and the X-axis is explained.
[0023] First, the exposure body section which imprints the pattern of the reticle R of this example on Wafer W is supported in the body frame 13 of a core box as a whole. And for Reticle R, it is held on the reticle stage 7 laid in the direction of Y possible [a scan] on the reticle base 8, and the two-dimensional location of a reticle stage 7 is the migration mirror 6 (biaxial [the amount of / for the object for the X-axes and Y-axes] is in fact.) on a reticle stage 7. the following -- the same . And it is measured by the laser interferometer 47 arranged on the plinth 48 on the body frame 13 corresponding to this, the main control system 49 by which this measurement value controls actuation of the whole equipment is supplied, and the reticle stage control system 9 controls the location and rate of a reticle stage 7 based on the control information from that measurement value and the main control system 49. A reticle stage system consists of the reticle base 8, a reticle stage 7, this drive (un-illustrating), etc., and the reticle base 8 is supported on the body frame 13 through the active mold vibration removal devices 14a and 14b (arranged in fact at three places). And a reticle stage system is contained in the reticle stage room 4 as a sealed cabin, and the transparency aperture 12 is provided in the side attachment wall of the reticle stage room 4 so that the laser beam for measurement can go back and forth between a laser interferometer 47 and the migration mirrors 4.
[0024] The active mold vibration removal devices 14a and 14b are devices which are constituted combining the Ayr damper and electromagnetic actuators (voice coil motor etc.), intercept vibration of high frequency with the Ayr damper, are made to generate the vibration for offsetting vibration of low frequency from an actuator, and prevent transfer of vibration of a large frequency region. What vibration produced by the scan of a reticle stage 7 transmits to the body frame 13 according to the active mold vibration removal devices 14a and 14b is prevented.
[0025] Furthermore, in order that the vibration accompanying the scan of a reticle stage 7 may raise the airtightness of the optical path of exposure light, preventing transmitting to projection optics PL

and the illumination-light study system 3 The reticle stage room 4 and the upper part of projection optics PL It connects by the covering member 15 which has the flexibility (that is, vibration is not transmitted) formed for the low film material of gas permeability etc., and the covering member 11 as the covering member 15 with same reticle stage room 4 and illumination-light study system 3 connects. Vibration proof and airtightness can be reconciled by this. In addition, the window part 10 which makes the exposure light IL penetrate is installed in the reticle stage room 4 between the illumination-light study system 3 and Reticle R.

[0026] on the other hand, Wafer W is held on the wafer stage (Z leveling stage) 38 through a non-illustrated wafer holder -- having -- the wafer stage 38 -- a wafer base 40 top -- the direction of Y -- a scan -- possible -- and the direction of X and the direction of Y -- a step -- it is laid movable. The two-dimensional location of the wafer stage 38 is measured by the migration mirror 38 on the wafer stage 38, and the laser interferometer 43 arranged in the body frame 13 corresponding to this, this measurement value is supplied to the main control system 49, and the wafer stage control system 41 controls the location and rate of the direction of X of the wafer stage 38, and the direction of Y based on the control information from this measurement value and the main control system 16. Moreover, based on the information on the focal location (location of a Z direction) in two or more measure points of the front face of the wafer W from a non-illustrated automatic focus sensor (sensor optical by the oblique incidence method), the wafer stage 38 controls the surrounding tilt angle of the focal location of Wafer W and the X-axis, and a Y-axis by the servo system so that the front face of Wafer W focuses during exposure in the image surface of projection optics PL.

[0027] A wafer stage system consists of the wafer base 40, a wafer stage 38, this drive (un-illustrating), etc., and the wafer stage system is contained in the wafer stage room 45 as a sealed cabin. The transparency aperture 50 is provided in the side attachment wall of the wafer stage room 45 so that the laser beam for measurement can go back and forth between a laser interferometer 43 and the migration mirrors 39. In order to prevent that that vibration is transmitted to the body frame 13 although vibration occurs with the acceleration for that scan even if it faces the scan of this wafer stage 38, the wafer stage room 45 is installed on the pars basilaris ossis occipitalis of the body frame 13 through the active mold vibration removal devices 44a and 44b (arranged in fact at three places). Moreover, in order to secure the airtightness between the wafer stage room 45 and projection optics PL, preventing the transfer to the projection optics PL of vibration of the wafer stage 38 It connects like the case of the reticle stage room 4 by the covering member 46 which has the flexibility (that is, vibration is not transmitted) formed for the low film material of gas permeability etc. between the upper part of the wafer stage room 45, and the lower limit section of projection optics PL.

[0028] Moreover, the fixed mirrors 26 and 36 (biaxial [the amount of / for the object for the X-axes and Y-axes] is actual, respectively) are attached in the upper limit side face and lower limit side face of projection optics PL, respectively, it is measured by the laser interferometers 27 and 42 by which the location of the fixed mirrors 26 and 36 was installed in the body frame 13, respectively, and this measurement value is supplied to the main control system 49. According to the location of the fixed mirrors 26 and 36, i.e., the location of projection optics PL, the location of a reticle stage 7 and the wafer stage 38 is amended like the after-mentioned, respectively.

[0029] Furthermore, since the exposure light IL of this example is vacuum-ultraviolet light, from the optical path of the exposure light IL from the exposure light source 1 to Wafer W, it needs to eliminate the powerful absorptivity gas (oxygen, a steam, a carbon dioxide, organic gas, etc.) of the absorption to vacuum-ultraviolet light, and needs to permute the optical path with the gas which penetrates the exposure light IL instead, i.e., a gas with the high transmission to the exposure light IL, (henceforth "purge gas"). As the purge gas, nitrogen, rare gas (helium, neon, an argon, a krypton, a xenon, radon), or these mixture of gas can be used, for example. In rare gas, since its amount of fluctuation of the refractive index to change of an atmospheric pressure is small, when helium excels [thermal conductivity] in temperature stability highly, and thinking the stability of an image formation property etc. as important, as purge gas, its helium is desirable. However, for an application which wants to hold down operation cost low, nitrogen may be used as purge gas.

[0030] So, in this example, the gas inside each sealed cabin which consists of the subchamber and the reticle stage room 4 where the beam matching unit 2 and the illumination-light study system 3 are contained, projection optics PL, and a wafer stage room 45 is permuted by the purge gas. As an

example, the permutation by the purge gas connects an exhaust pipe and a feed pipe to some septa of each sealed cabin, can supply the purge gas from a feed pipe, and can be performed from an exhaust pipe by the flow control into which made it make an internal gas flow. Furthermore, a purge gas permutation is possible also for decompressing the interior of a predetermined sealed cabin once, and being positively, re-filled up with purge gas there.

[0031] Where the image of the pattern of Reticle R is projected on one shot field on Wafer W through projection optics PL at the time of exposure, the actuation which carries out the synchronized drive of Reticle R and the wafer W in the direction of Y by making the image formation scale factor of projection optics PL into a velocity ratio, and the actuation which carries out step migration of the wafer W are repeated by step - and - scanning method, and the image of the pattern of Reticle R is imprinted by each shot field on Wafer W. Thus, although the projection aligner of this example is a scan exposure method, it cannot be overemphasized that this invention is effective also in the projection aligner of one-shot exposure molds, such as a stepper.

[0032] Here, with reference to drawing 2 , it explains per example of the lens configuration of the projection optics PL of this example. Drawing 2 is the sectional view showing the detailed configuration of the projection optics PL in drawing 1 , and is set to this drawing 2 . As an example the 1st lens group 24 in the 1st partial lens-barrel 16 Consisting of one lens 24a, the 2nd lens group 30 consists of lenses 30a-30e, the 3rd lens group 32 consists of lenses 32a-32e, and the lens group 22 in the 2nd partial lens-barrel 17 consists of lenses 22a and 22b. And Lenses 30a-30e are held in the common maintenance device 31, the maintenance device 31 is held in the partial lens-barrel 16 through two or more justification devices 52, Lenses 32a-32e are held in the common maintenance device 33, and the maintenance device 33 is held in the partial lens-barrel 16 through two or more justification devices 53. In addition, the concrete example of a configuration of the projection optics which consists of reflective refractive media like drawing 2 is indicated by JP,2000-47114,A.

[0033] Although return and the body frame 13 with which projection optics PL is held as mentioned above are once isolated from moving-part material (source of vibration), such as a reticle stage 7 and the wafer stage 38, so that vibration may not be transmitted, in addition, vibration of a certain extent being transmitted and vibrating projection optics PL still is not avoided by drawing 1 . In the case of complicated projection optics of a configuration like the projection optics PL of reflective refractive media which consists of two or more partial lens-barrels 16 and 17 with the optical axis extended in the mutually different direction which is used especially by this example, a majority of the normal mode of vibration also exists, and there is a possibility that optical system may vibrate easily according to slight external force.

[0034] For example, in the projection optics PL of this example, although fixed to the 1st partial lens-barrel 16, that it is easy to produce vibration like a rotational vibration centering on the joining segment cannot deny the 2nd partial lens-barrel 17. When such vibration arises, and the period of vibration is long, predetermined exposure time (imprint time amount of an image), for example, 100msec extent, of one point on Wafer W, the problem from which an image position shifts by the vibration occurs. Moreover, when the period of vibration is shorter than the exposure time, the problem that the sharpness of an image falls by vibration will arise.

[0035] In this example, the problem produced with the variation rate of the projection image by vibration of the partial lens-barrel of such 2nd partial lens-barrel 17 grade is solved by the following approaches. The fixed mirror 18 is formed in the external surface of the field near the concave mirror 21 of the 2nd partial lens-barrel 17, and the laser interferometer 19 is formed in the body frame 13 so that this may be countered. Namely, with this laser interferometer 19 The change of displacement of the distance to the fixed mirror 18 on the 2nd partial lens-barrel 17, i.e., the amount to the about Z directions in the location near the concave mirror 21 of the partial lens-barrel 17, is measured, and this measurement value is supplied to the main control system 49. Thereby, it is measured, the 2nd [to the body frame 13 (as a result, 1st partial lens-barrel 16)] the amount of location fluctuation of vibration, i.e., amount, of the partial lens-barrel 17. The tables (or approximate expression etc.) required in the count based on the design data in the operation part in the main control system 49 or a prior experiment can determine the relation between the amount of location fluctuation of the 2nd partial lens-barrel 17, and the amount of displacement of the projection image of a reticle pattern.

[0036] So, by the main control system 49, the amount of gaps from the ideal location of the

projection image of the reticle pattern on Wafer W is computed from the amount of location fluctuation of the 2nd partial lens-barrel 17 measured by the laser interferometer 19 (variation rate amount). The computed amount of location gaps is sent to the reticle stage control system 9 or the wafer stage control system 41, it is in the condition that position control of a reticle stage 7 or the wafer stage 38 was performed, and exposure is performed in the direction which offsets this amount of location gaps. It can prevent vibration of the 2nd partial lens-barrel 17 serving as a location gap of a reticle pattern projection image, and degrading the image formation property and exposure precision of an imprint image (imprint fidelity, superposition precision, etc.) by this. In addition, in order to amend the amount of location gaps, both a reticle stage 7 and the wafer stage 38 may be driven.

[0037] In addition, as for the above-mentioned amendment, it is needless to say that this may be measured and amended also about deformation of a configuration member like deformation of the body frame 13 which it is not applied only to the so-called vibration and produced by migration of the wafer stage 38 and a reticle stage 7. Moreover, with the gestalt of the above-mentioned operation, although a laser interferometer 19 shall perform measurement of vibration (location fluctuation) of the 2nd partial lens-barrel 17, an acceleration sensor 20 may be attached in the 2nd partial lens-barrel 17, and the acceleration of the partial lens-barrel 17 may instead be measured by the acceleration sensor 20. Also in this case, that measurement value is supplied to the main control system 49. And the amount of location fluctuation of the partial lens-barrel 17 can be calculated by integrating the operation part in the main control system 49 with the acceleration twice, and calculating the amount of fluctuation of the integral value. It is also possible to carry out in the processing unit (un-illustrating) which did not perform the integral of the acceleration in the main control system 49, but was prepared near the acceleration sensor 20.

[0038] In addition, the fixed mirror for measuring the location of projection optics forms in the upper limit (the near reticle) and the lower limit (the near wafer) of projection optics which met at the optical axis also in the projection aligner which uses the projection optics of the straight cylinder mold with which the lens group has been arranged on one optical axis of a conventional type, the location measures with a laser interferometer, and the approach of amending a location gap of the projection image resulting from vibration and location fluctuation of projection optics is adopted. Then, like this, near the reticle R side of the 1st partial lens-barrel 16 in projection optics PL, and the Wafer W side, the fixed mirrors 26 and 36 are installed, respectively and the location is measured also in this example with the laser interferometers 27 and 42 installed in the body frame 13. It cannot be overemphasized that the amount of location gaps of the projection image of the reticle pattern accompanying vibration of the 1st partial lens-barrel 16 and the amount of location gaps which are measured by these laser interferometers 27 and 42 can also be amended by migration of a reticle stage 7 and the wafer stage 38.

[0039] Moreover, to measure the amount of displacement of a partial lens-barrel as mentioned above and predict the amount of location gaps of a projection image (calculation), the relation between the amount of displacement of a partial lens-barrel and the amount of location gaps of a projection image needs to become clear beforehand. Since this relation is theoretically computable from optical design data and machine design data, it can amend the location of a reticle, a wafer, or both according to this theoretical value.

[0040] Moreover, it is also possible to measure the relation between the amount of displacement of a partial lens-barrel and the amount of location gaps of a projection image, and to memorize this measurement result in the form of a table or an approximate expression by experiment, beforehand. For example, in the location (the image surface) where a wafer is arranged, the sensor in which location measurement of an image sensor, a knife-edge sensor, etc. is possible can arrange, can make it able to carry out the specified-quantity [every] variation rate of the partial lens-barrel for [in projection optics] measurement, where the projection image of a reticle pattern is projected on this sensor, and it can ask for the relation between the amount of displacement of that partial lens-barrel, and the amount of location gaps of a projection image experimentally by measuring a location gap of that projection image by that sensor. In this case, the variation rate of that partial lens-barrel can be produced by carrying the manual or predetermined weight by the operator etc.

[0041] In addition, in the gestalt of the above operation, although the 1st lens group 24, the 2nd lens

group 30, and the 3rd lens group 32 shall be held by the same partial lens-barrel 16, they may be held as the other configuration at the partial lens-barrel with each respectively different lens groups 24, 30, and 32. Moreover, it is desirable to install the metering devices (a laser interferometer, a gap sensor, acceleration sensor, etc.) which measure the amount of displacement of the partial lens-barrel according to each individual of relative displacements, for example, the amount to the body frame 13, in that case.

[0042] Moreover, with the gestalt of the above-mentioned operation, although the reflecting mirrors 28a and 28b of the 2nd page shall be formed in one on one member (reflecting mirror block 29), the reflecting mirrors 28a and 28b of two sheets may be formed on the separate member. However, while it is [adjustment] easier to form the reflecting mirrors 28a and 28b of the 2nd page in one, the advantageous thing is natural also in respect of stability.

[0043] Moreover, although a lens and a reflecting mirror shall be included in the 2nd partial lens-barrel 17 which performs location measurement with the gestalt of the above-mentioned operation, naturally it is also possible to measure the location of the partial lens-barrel only containing a reflecting mirror and the partial lens-barrel only containing a lens, and to perform location amendment of a reticle stage 7 or the wafer stage 38 based on the result. moreover, although the projection optics PL of the gestalt of the above-mentioned operation is equipped with two partial lens-barrels with the optical axis extended in the mutually different direction, other than this, it is alike and applying this invention also to the projection optics which has three or more partial lens-barrels with the optical axis extended in the mutually different direction cuts. in this case -- for example, what is necessary is to measure the location of each other partial lens-barrel on the basis of a predetermined criteria location (for example, partial lens-barrel nearest to a wafer), to predict a location gap of the projection image on the wafer accompanying it (calculation), and just to amend the location of a reticle or a wafer, or both locations from the amount of location gaps measured Moreover, you may make it measure only the location of the partial lens-barrel which has biggest effect on the amount of location gaps of a projection image among two or more partial lens-barrels.

[0044] Moreover, this invention has optical system with the optical axis which faces to a wafer from a reticle, and cata-dioptric system with the optical axis which intersects perpendicularly mostly to the optical axis, and also when using the reflective refraction projection optics which forms a middle image twice inside, it can apply them, as indicated by the application for patent 2000-59268 as projection optics. Furthermore, the measurement direction of the partial lens-barrel for measurement is not what is restricted in the direction (about Z directions) of one dimension like the gestalt of the above-mentioned operation. Location measurement may be performed about the two-dimensional direction also including the direction of X of the gestalt of the above-mentioned operation, and the direction of a three dimension which also includes the direction of X, and the direction of Y further, a location gap of the projection image on a wafer may be predicted from the measurement result (calculation), and the location of a reticle or a wafer or both locations may be amended. In this case, amendment of a reticle location or a wafer location is not limited in the direction of one dimension, either, but can carry out location amendment in the two-dimensional direction, respectively. Moreover, it may be made to perform location amendment of a reticle or the direction of a focus of a wafer (direction perpendicular to a wafer side or the pattern side of a reticle), for example.

[0045] Furthermore, you may make it measure the amount of fluctuation of the tilt angle of the partial lens-barrel, or the deformation amount of the partial lens-barrel with the location measurement, for example instead of measuring the location of the partial lens-barrel for measurement. When manufacturing a semiconductor device on a wafer using the projection aligner of the gestalt of the above-mentioned operation, in addition, this semiconductor device The step which performs the function and engine-performance design of a device, the step which manufactures the reticle based on this step, The step which makes a wafer from a silicon ingredient, the step which performs alignment with the projection aligner of the gestalt of the above-mentioned operation, and exposes the pattern of a reticle to a wafer, It is manufactured through a device assembly step (a dicing process, a bonding process, and a package process are included), an inspection step, etc.

[0046] Moreover, it can apply also to the aligner for, for example, manufacturing various devices, such as an aligner for display units, such as a liquid crystal display component formed in the glass

plate of a square shape, or a plasma display, and image sensors (CCD etc.), a micro machine, the thin film magnetic head, a DNA chip, widely, without being limited to the aligner for semiconductor device manufacture as an application of the aligner of this invention. Furthermore, this invention is applicable also to the exposure process (aligner) at the time of manufacturing the masks (a photo mask, reticle, etc.) with which the mask pattern of various devices was formed using a photolithography process.

[0047] In addition, of course, configurations various in the range which this invention is not limited to the gestalt of above-mentioned operation, and does not deviate from the summary of this invention can be taken.

[0048]

[Effect of the Invention] When exposing using the reflective refraction projection optics which has two or more partial lens-barrels with the optical axis extended in the mutually different direction according to this invention, degradation of the image by vibration peculiar to the cata-dioptric system of a configuration complicated such can be suppressed. By this, conventionally, implementation became realizable [the projection aligner which uses light of the difficult vacuum ultraviolet area as an exposure beam], and it became realizable [the projection aligner whose resolution improved as the result more sharply than before].

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram which cut and lacked the part which shows the projection aligner of an example of the gestalt of operation of this invention.
[Drawing 2] It is the sectional view showing an example of the concrete lens configuration of the projection optics PL in drawing 1 .
[Description of Notations]
1 -- The exposure light source, R -- A reticle, PL -- Projection optics which consists of reflective refractive media, W [-- The 1st partial lens-barrel,] -- A wafer, 7 -- A reticle stage, 13 -- A body frame, 16 17 [-- Acceleration sensor,] -- The 2nd partial lens-barrel, 18 -- A fixed mirror, 19 -- A laser interferometer, 20 21 [-- A reflecting mirror, 29 / -- A reflecting mirror block, 30 / -- The 2nd lens group, 32 / -- The 3rd lens group, 38 / -- A wafer stage, 49 / -- Main control system] -- A concave mirror, 22 -- A lens group, 24 -- The 1st lens group, 28a, 28b

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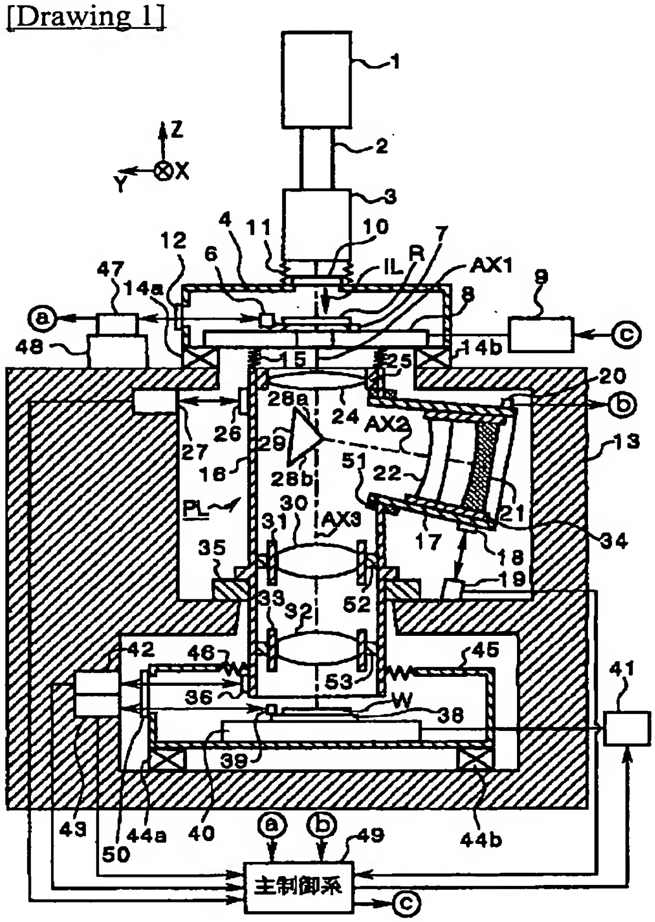
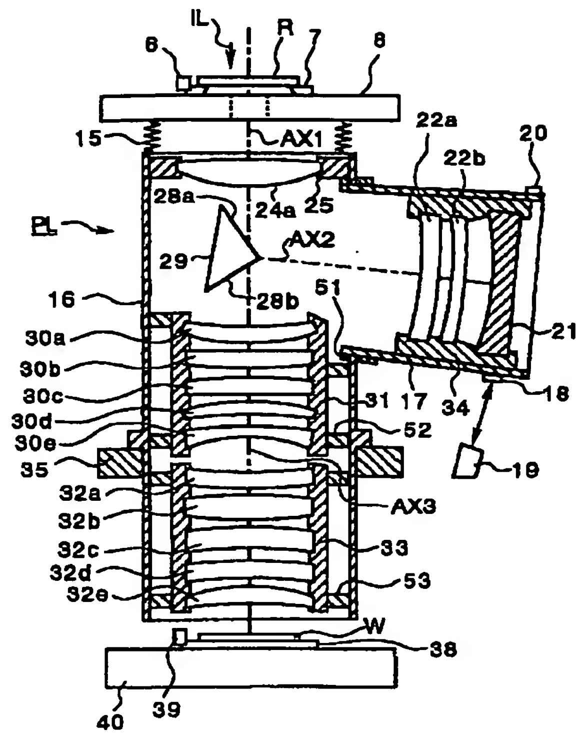
[Translation done.]

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]